

# Flexible consensus in ant cooperative transport



*BIOSS*  
Montpellier, March, 2017

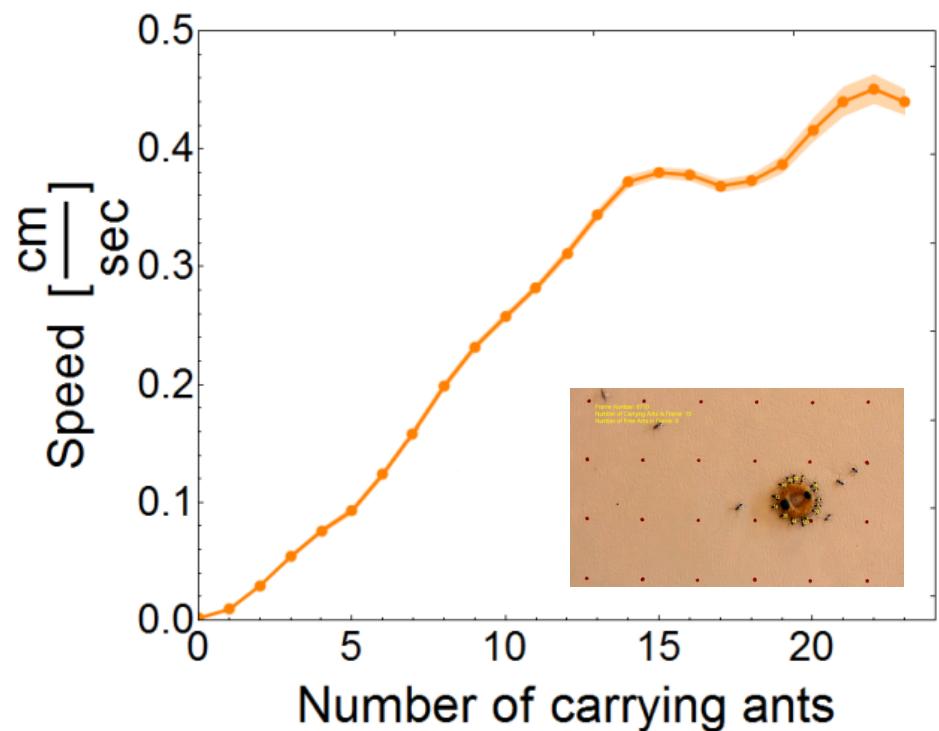
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# Cooperative Transport



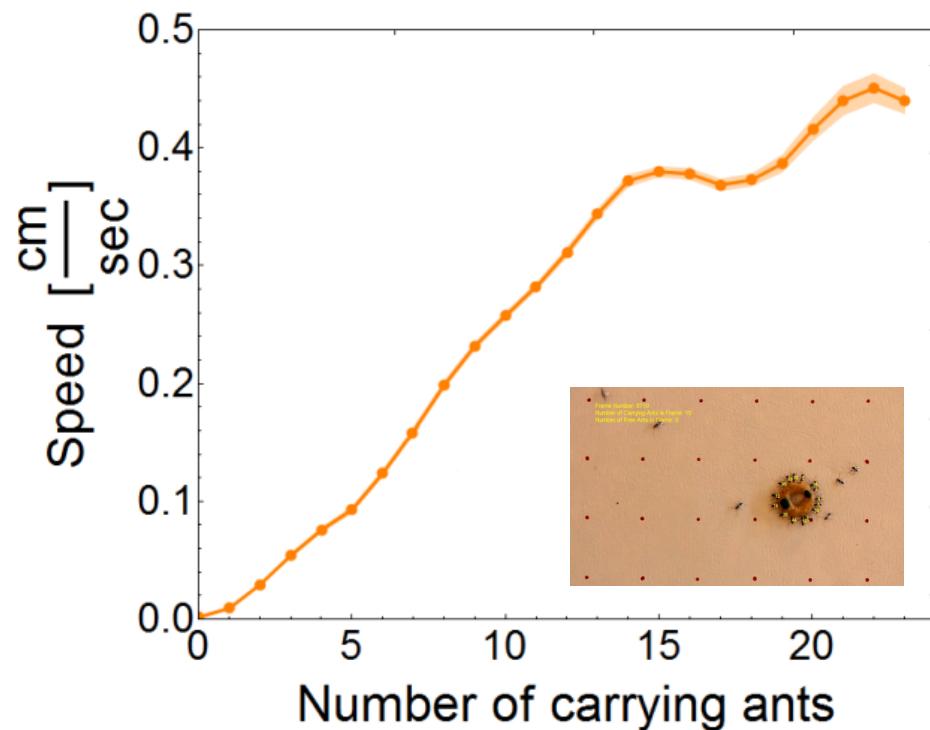
# Consensus in force application

## Macroscopic evidence



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Macroscopic evidence

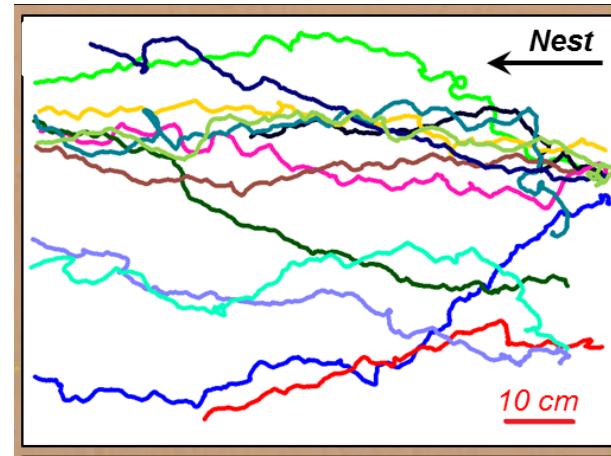


Microscopic mechanism

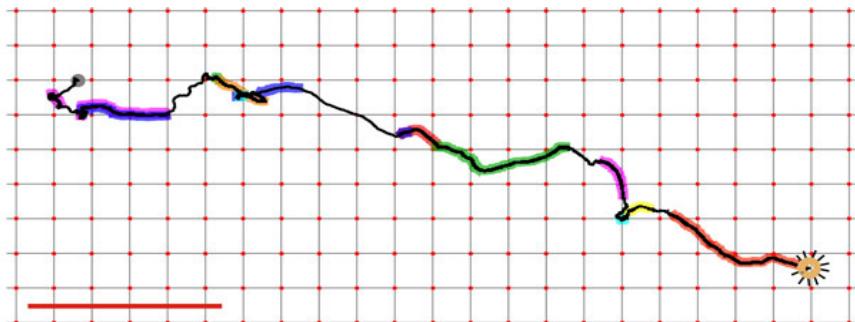


# What about directionality?

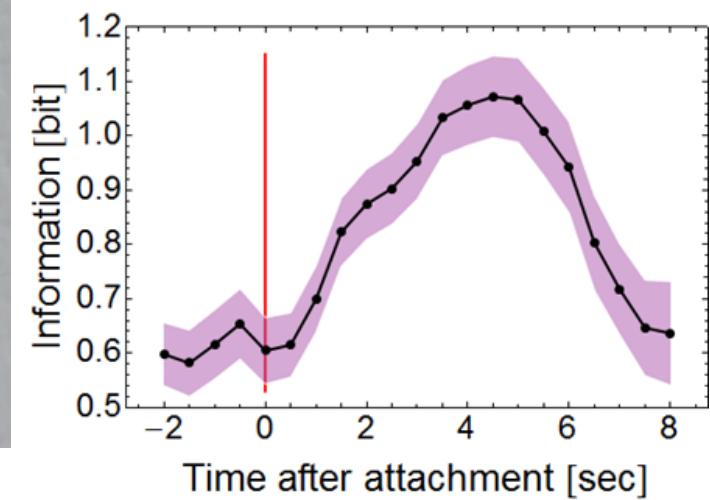
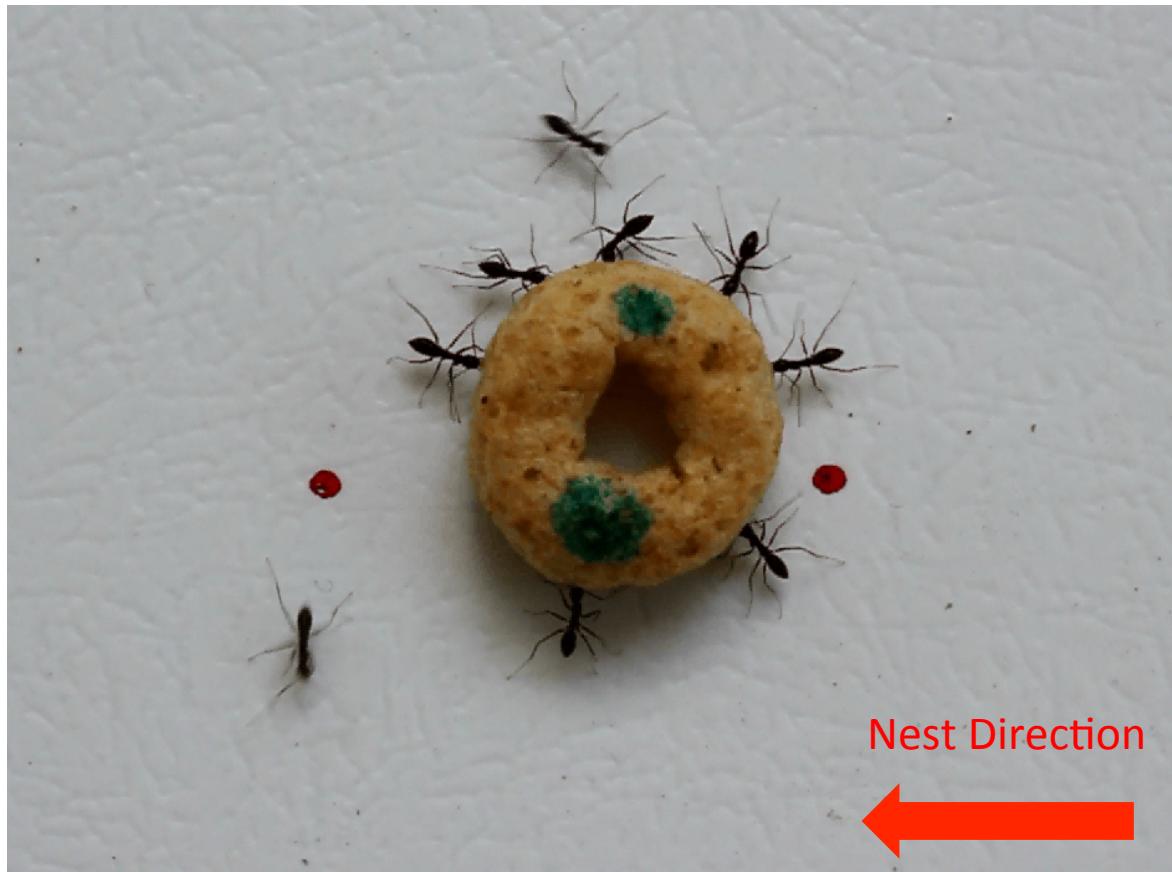
Option 1: Carriers independently know the way to the nest.



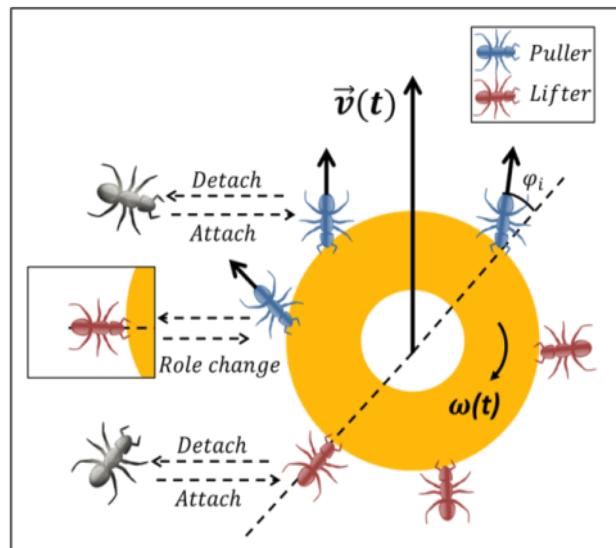
Option 2: The carriers follow a single knowledgeable leader



# Leadership of the (transiently) informed



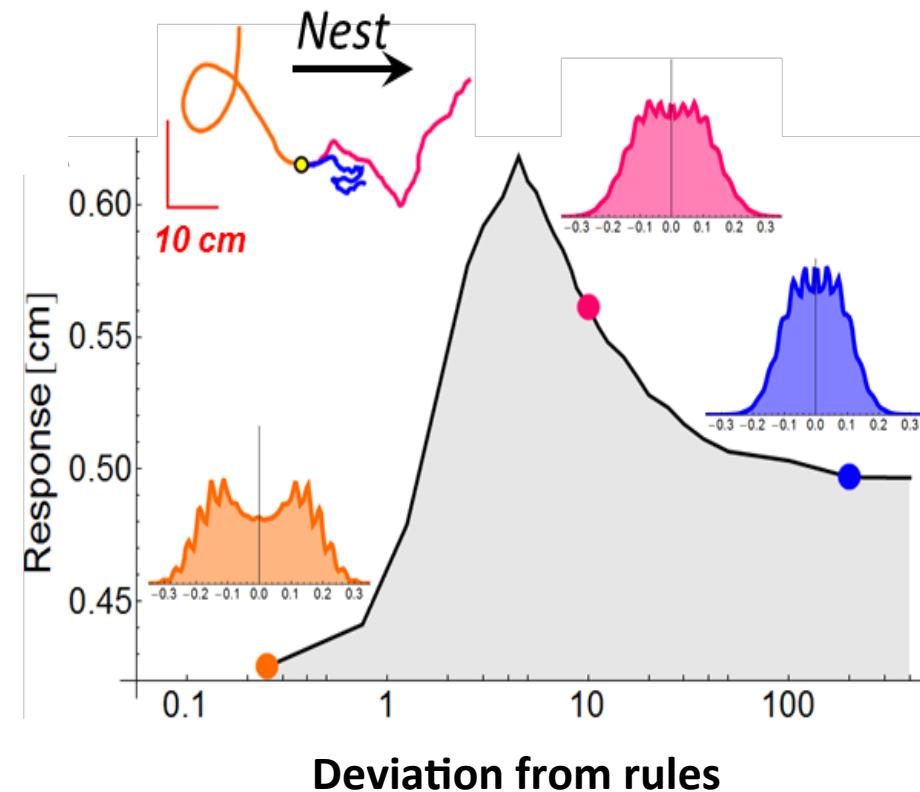
# Mechanism: How does the leader gain control?



The only interactions  
are force mediated.

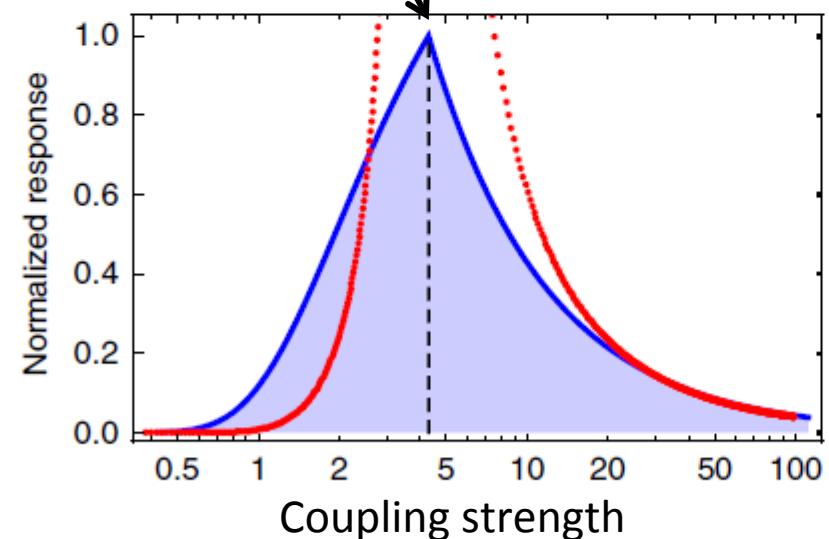
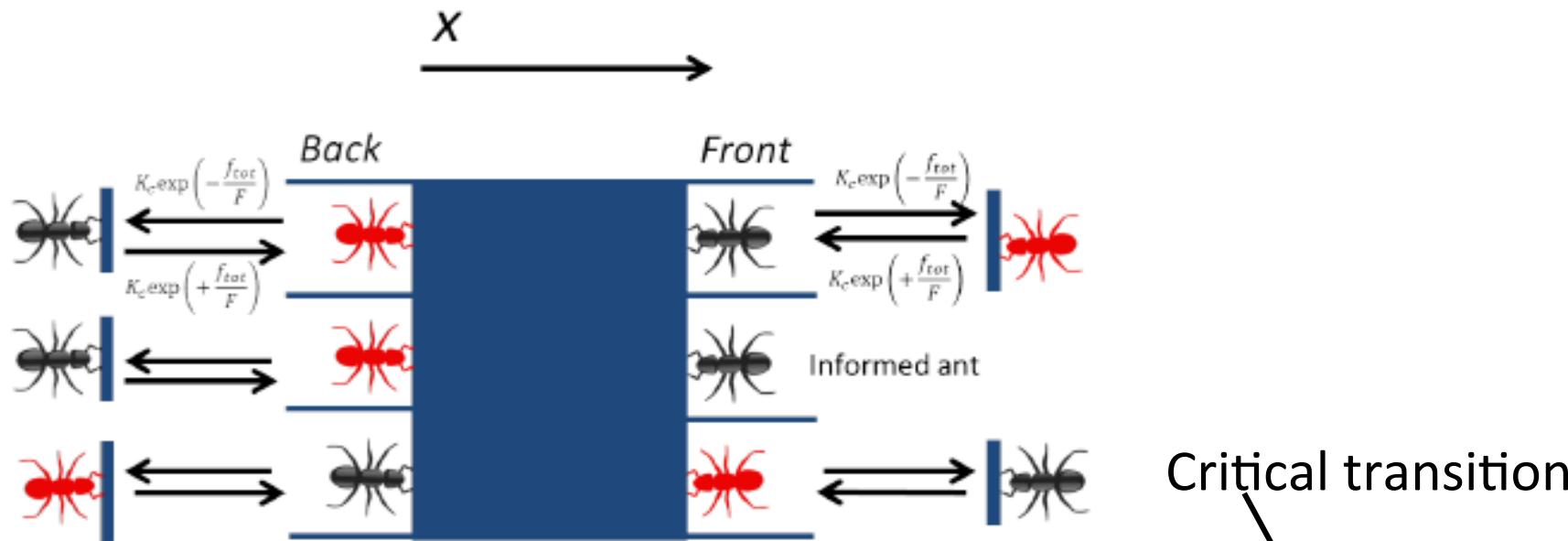
**Leader:** pull home, ignore rest.

**Other:** Conform to current direction.

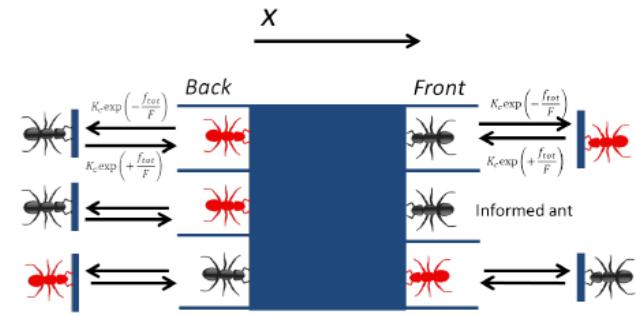


**Note:** Maximal response to leader at the order-disorder transition.

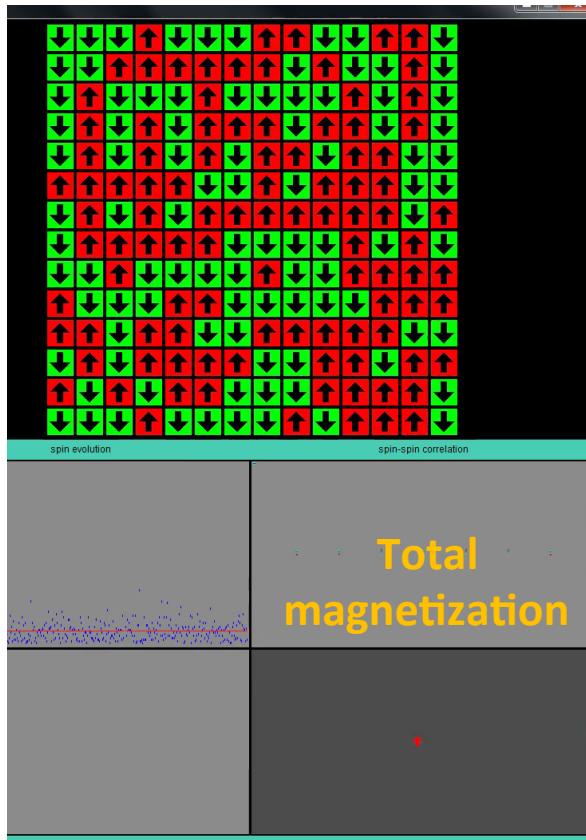
# Map to Ising model



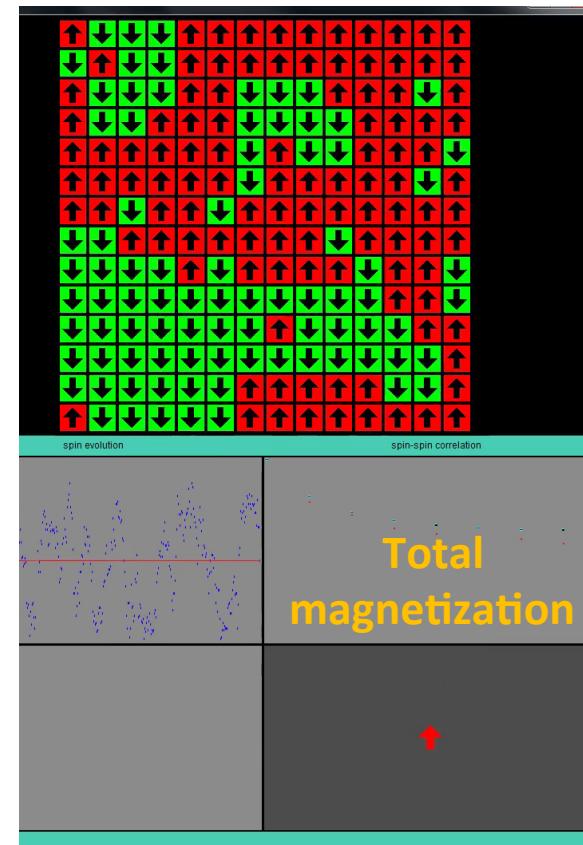
# Divergence of Susceptibility



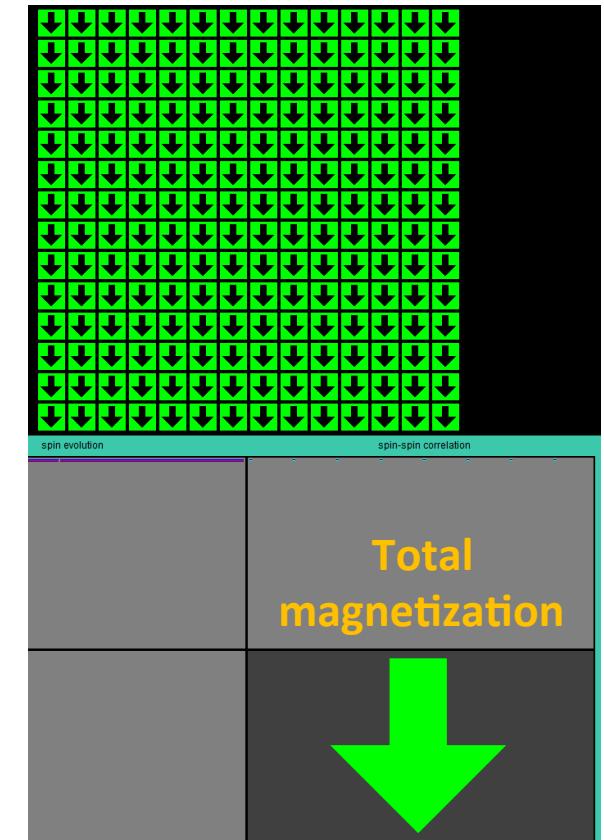
Weak coupling



critical

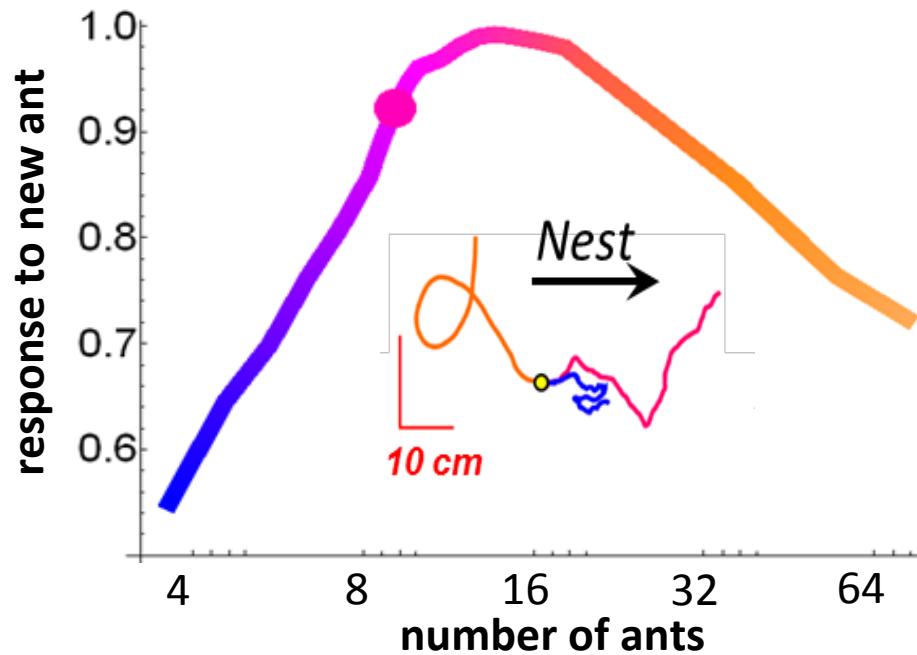


Strong coupling

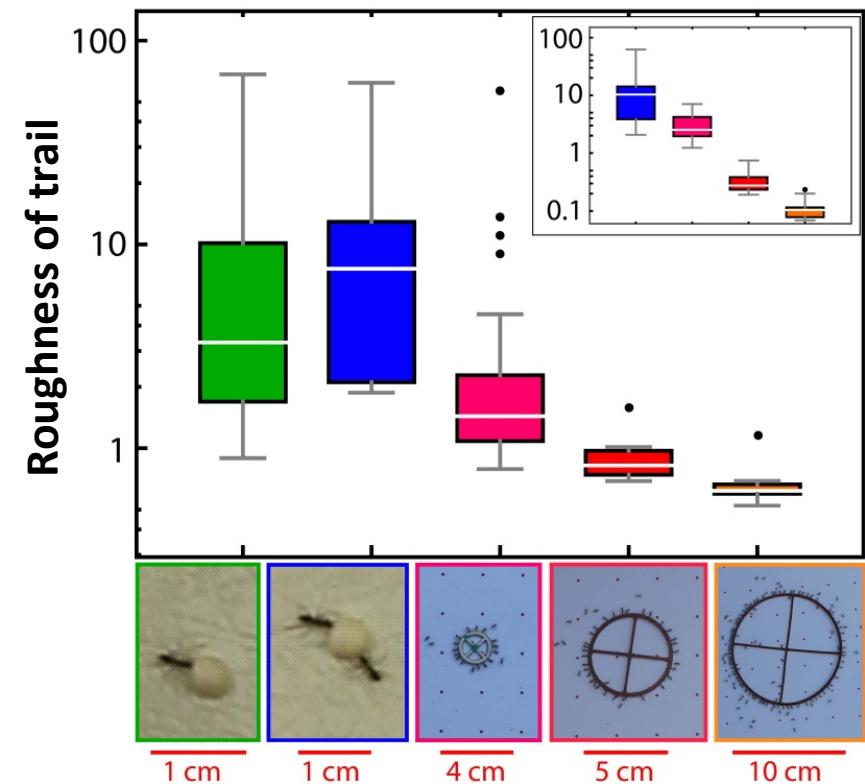


# Towards Experimental confirmation

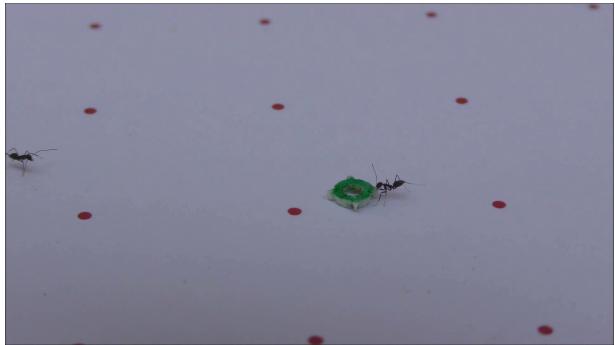
Single ant conformism  $\leftrightarrow$  Social Pressure



Experimentally:  
The efficiency of conformism



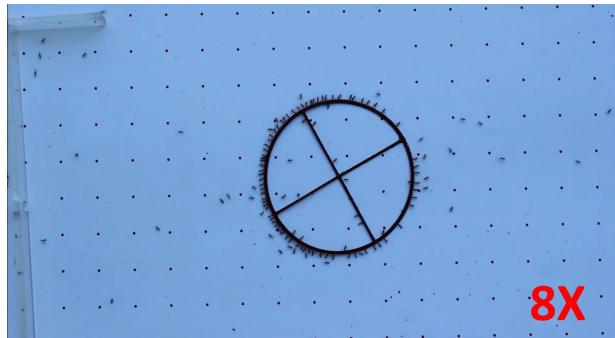
# Experimental evidence for optimality



$R \ll 1\text{cm}$   
Small group. No coordinated movement.



$R \sim 1\text{cm}$   
Optimal size. Between ballistic and random motion.



$R \sim 4\text{cm}$   
Large group: Smooth motion but can't negotiate obstacles.



**“brains”**

**“muscle”**

# Is this always the case?

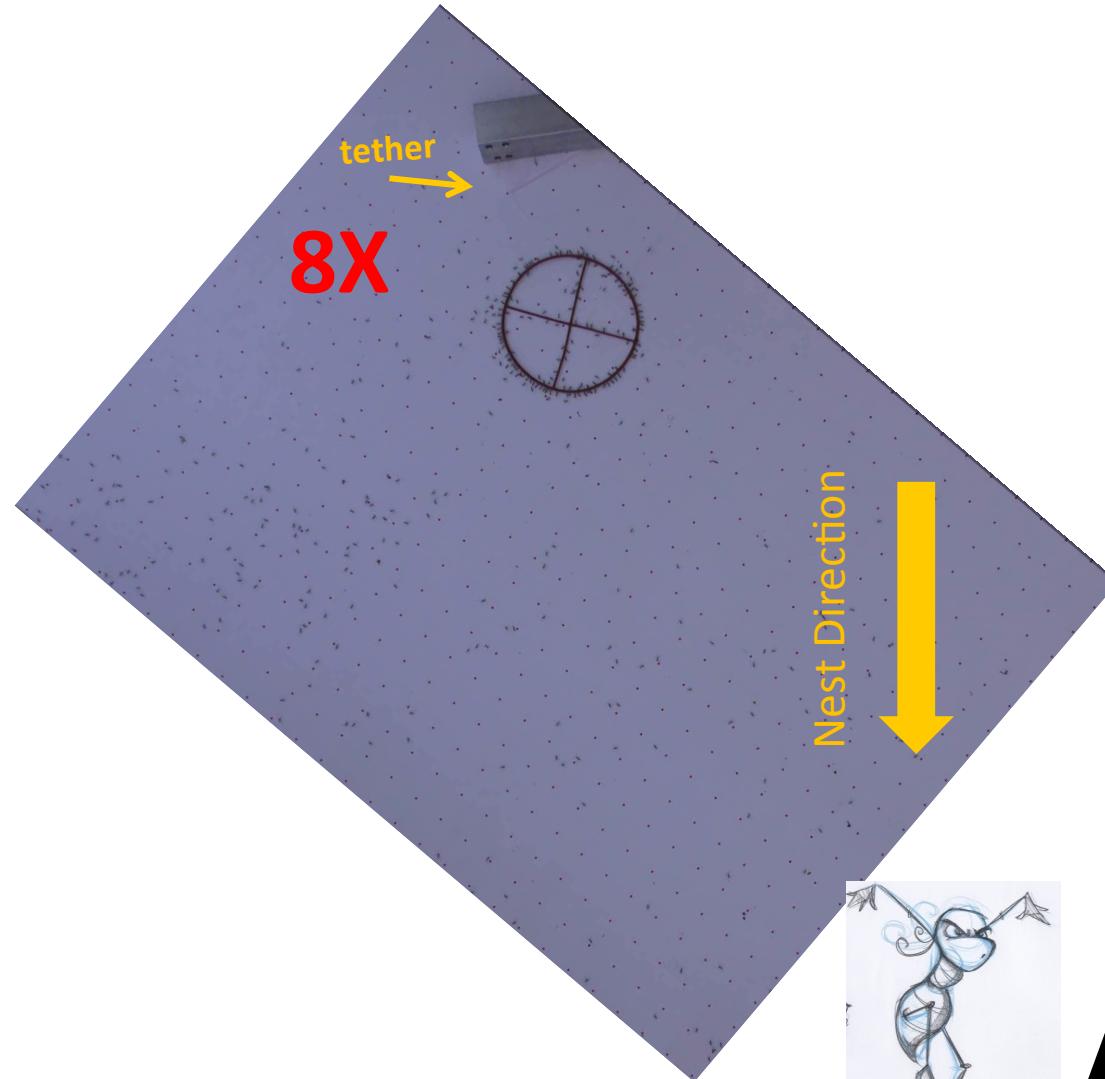


?

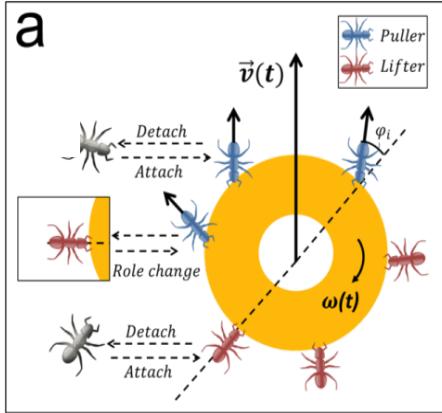


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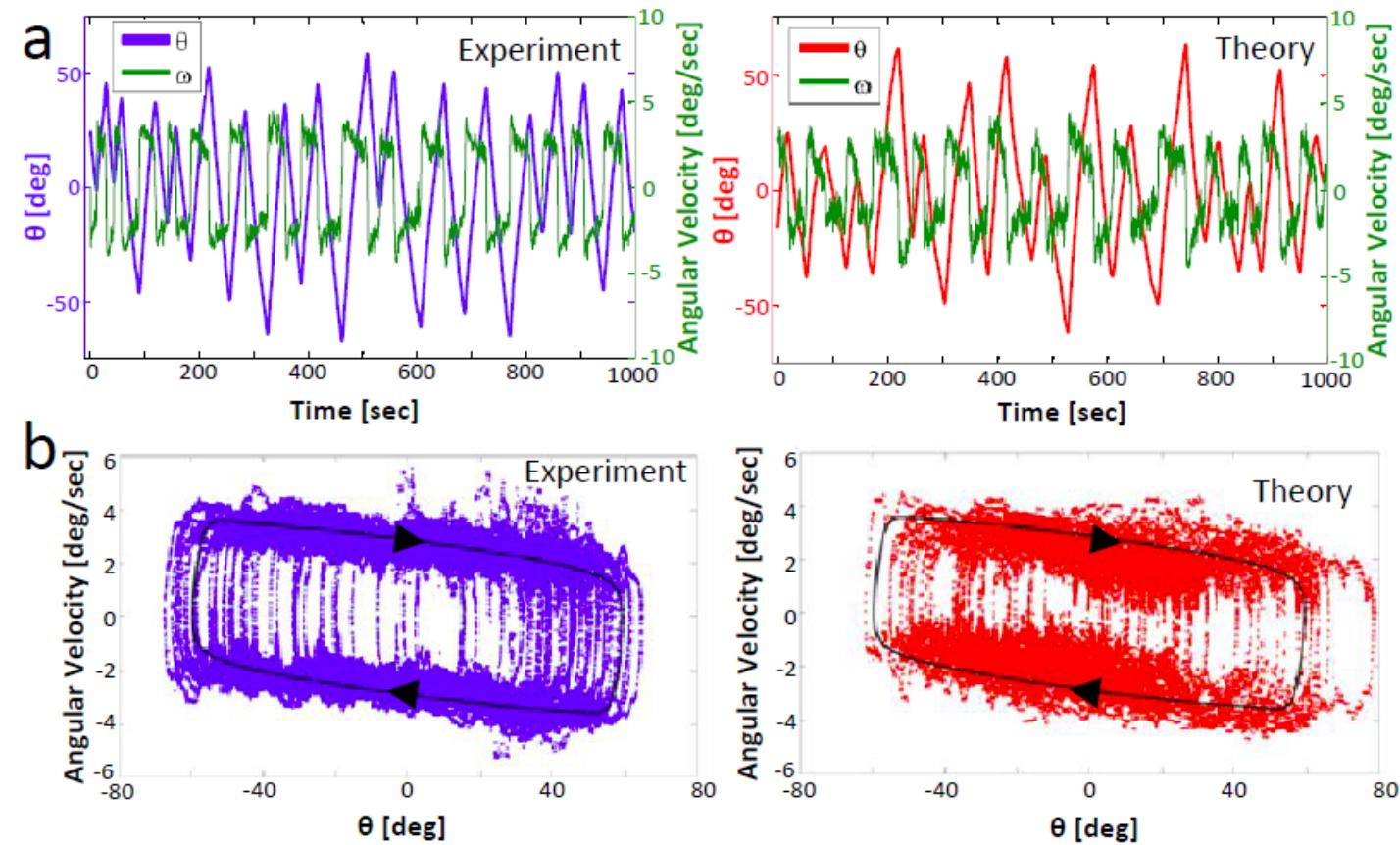
# An ant-invisible barrier



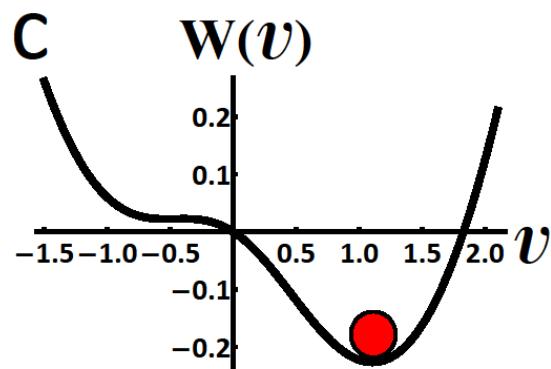
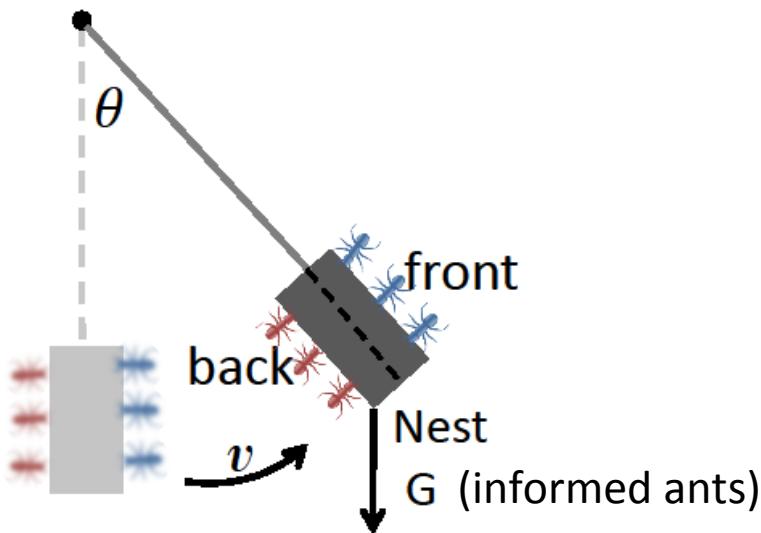
?



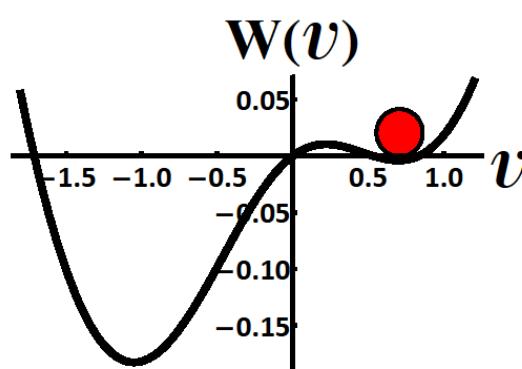
# previous model



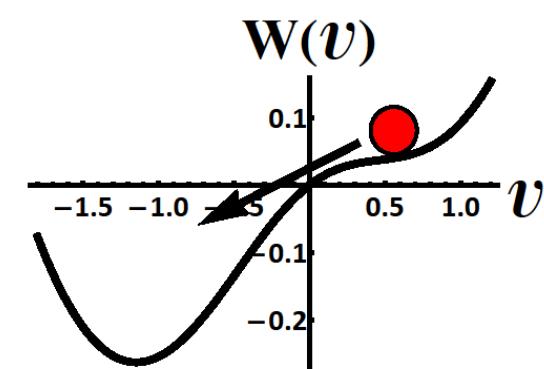
# Emergent relaxation oscillations



$\Theta < 0$



$\Theta > 0$



$\Theta \sim \Theta_{\max}$

# Who makes the calls in an ant colony?



**Top down**



**Bottom up**



# thanks

## Lab members

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## Collaborations

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